could create such a School of Mathematics as might go some way at least to revive the old scientific renown of Oxford, and to light such a candle in England as, with God's grace, should never be put out.[1]

TABLES OF SINGULARITIES AND FORMULÆ REFERRED TO IN THE PRECEDING LECTURE

CHART 1.

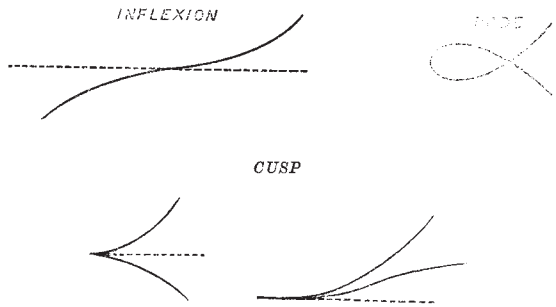

CHART 2.—PROTOMORPHS

Binariants	*Reciprocants*
a	a
$ac-b^2$	$3ac-5b^2$
$a^2d-3abc+2b^3$	$9a^2d-45abc+40b^3$
$ae-4bd+3c^2$	$5a^2e-35abd+7ac^2+35b^2c$
$a^2f+5abe+2acd+8b^2d-6bc^2$	$45a^2f-420a^2be-42a^2cd+1120ab^2d$ $-315abc^2-1120b^3c$
$ag-6bf+15ce-10d^2$	$a^2g-120abf-450ace+792b^2e$ $+588ade^2-2772bcd+1925c^3$

CHART 3.

No. 1. a
No. 2. $3ae-5b^2$
No. 3. $9a^2d-45abc+40b^3$
No. 4. $45a^3d^2-450a^2bc+192a^2c^3+400ab^3d+165ab^2c^2-400b^4c$

$$x=\int\frac{dt}{\sqrt{\kappa(1-15t^2+15t^4-t^6)+\lambda(3t-10t^3+3t^5)}}+\mu$$

$$y=\int\frac{tdt}{\sqrt{\kappa(1-15t^2+15t^4-t^6)+\lambda(3t-10t^3+3t^5)}}+\nu$$

$$V=3a^2\delta_b+10ab\delta_c+(15ac+10b^2)\delta_d+(21ad+35bc)\delta_e+(28ae+56bd+35c^2)\delta_f+\ldots$$

[1] I have purposely confined myself in my lecture to reciprocants, indicatives of properties of plane curves, but had in view to extend the theory to the case of higher dimensions in space leading to reciprocants involving the differential derivatives of any number of variables $y, z, \ldots$. M. Halphen, with whom I have had the great advantage of being in communication during my stay in Paris, has anticipated me in this part of my plan, and has found that the same method which I have used to obtain the Annihilator V applied to a system of variables leads to an Annihilator of very similar form to V, and at my request will publish his results in a forthcoming number of the *Comptes rendus*. Thus the dominion of reciprocants is already extended over the whole range of forms unlimited in their own number as well as in that of the variables which they contain

CHART 4.—COEFFICIENTS OF ANNIHILATOR V

1	4	3			
1	5	10			
1	6	15	10		
1	7	21	35		
1	8	28	56	35	
1	9	36	84	126	
1	10	45	120	210	126

CHART 5.—RECIPROCANT TRANSFORMATIONS

Grub	*Chrysalis*			*Imago*		
$\frac{d^2y}{dx^2}$	$\frac{d^2\phi}{dx^2}$	$\frac{d^2\phi}{dxdy}$	$\frac{d\phi}{dx}$	$\frac{d^2\Phi}{dx^2}$	$\frac{d^2\Phi}{dxdy}$	$\frac{d^2\Phi}{dxdz}$
	$\frac{d^2\phi}{dxdy}$	$\frac{d^2\phi}{dy^2}$	$\frac{d\phi}{dy}$	$\frac{d^2\Phi}{dxdy}$	$\frac{d^2\Phi}{dy^2}$	$\frac{d^2\Phi}{dydz}$
	$\frac{d\phi}{dx}$	$\frac{d\phi}{dy}$	•	$\frac{d^2\Phi}{dxdz}$	$\frac{d^2\Phi}{dydz}$	$\frac{d^2\Phi}{dz^2}$

$$(a)\qquad (M)\qquad (H)$$
$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3 a+H+\left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2}\quad\left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi=0.$$

$\frac{dy}{dx}\frac{d^3y}{dx^3}-\frac{3}{2}\left(\frac{d^2y}{dx^2}\right)^2$ is the Schwarzian, otherwise written $tb-\frac{3a^2}{2}$.

CHART 6.—THE H RECIPROCANTIVE PROTOMORPH

U	W	*The Vermicular Operator*
$65a^4h$	$120a^3cf$	$\lambda a\delta_b+\mu b\delta_c+\nu c\delta_d+\pi d\delta_e+\ldots$
$-975a^3bg$	$-200a^2b^2f$	
$-990a^3cf$	$-195a^2de$	*Examples*
$+6200a^2b^2f$	$-145a^2bce$	$a\delta_b+b\delta_c+c\delta_d+d\delta_e+\ldots$
$+4690a^2bce$	$+1000ab^3e$	$a\delta_b+2b\delta_c+3c\delta_d+4d\delta_e+\ldots$
$-1540ab^3e$	$+1365a^2bd^2$	$3a\delta_b+8b\delta_c+15c\delta_d+24d\delta_e+\ldots$
$-2730a^2bd^2$	$-777a^2c^2d$	
$+7161a^2c^2d$	$-22260ab^2ca$	☞ b^4d does not appear in either U or W.
$+3080ab^2cd$	$+2485abc^3$	
$-24255abc^3$	$+105b^3c^2$	
$+25410b^3c^2$		

$H+\Lambda U+MW$

Λ and M are arbitrary numbers.

New College, Oxford, January 6

THE GEOLOGY OF MALAYSIA, SOUTHERN CHINA, &c.

THERE is a remarkable uniformity in the geology of a very large portion of Southern Asia and its dependent islands, especially from the Malay peninsula, as far east as the Philippines, and as far north as the Chinese continent. In the Malayan peninsula we have an elevated granitic axis. At the base of this there are Palæozoic schists and slates. Above these in a few places there are limestones in detached weathered masses. This limestone is often crystalline, white, blue, and black. In a few cases there are traces of stratification, but no fossils.

In a recent journey through Pahang I found precisely the same formations on the eastern side of the peninsula, with only this addition, that there is a belt of trachytic rocks of modern origin forming detached hills between the main range and the sea.

In Sumatra I learn that there are the same formations from the granite upwards. I cannot confirm this from personal observation, as I have travelled very little in the island. The mountain axis is far from the Straits of Malacca, and difficult of access. As far as I can judge from the geology of such large islands as Bilitou, Bintang, and Banca, the mountains are probably granitic and stanniferous.

Proceeding eastward and northerly, detached granite islands are met with. They are thickly strewn through the intermediate ocean. Those I have seen, such as the north and south Natunas, and other similar outliers, on voyages between Java, Singapore, Borneo, China, Cochin

China, and Siam, are all granitic, with a few Palæozoic slates and schists. To the eastward of the Malay peninsula a few limestone islands are seen, and they are similar in character to the calcareous rocks of the mainland.

It is perhaps needless to draw attention to the extraordinary number of these outliers. They do not show well on a map, as most of them are so very small, but those who travel in these regions can well understand why the early Arabian voyagers called this "the sea of the twelve thousand islands." Granite is the prevailing rock, but I have little doubt that modern trap-rocks form some of the islands. But there is no active volcano amongst them. The nearest point for such phenomena is said to be Formosa, but I think this doubtful. Yet, proceeding north from this large island, along the chain which connects it in an almost unbroken series through the Meiaco group, Liu Kiu and Linschoten Islands, to Japan, we find two active volcanoes (Naka Sima and Sawa Sima, the latter 3400 feet high), which seem to point to a line of disturbance, of which Formosa is a portion.

When we come to Borneo we find the first extensive development of stratified rocks. Though outliers of granite are met occasionally, it is evident that there is a great change in the geology of the coast. I shall confine my observations to what I saw. From Brunei northwards we meet with carbonaceous rocks, brown and yellow sandstones and shales with intercalated grits and conglomerates. The dip varies: sometimes slight, or nearly horizontal, showing but trifling disturbance in this part of the world. It seemed to me as if these carbonaceous rocks were of different ages. Those which line the Brunei River are much older-looking than those of Labuan. At Gaya, and again at Kudat, at the north extremity of Borneo, I saw brownish-yellow sandstones with shales and small seams of coal. The appearance of these beds reminded me much of the Mesozoic carbonaceous rocks of Queensland and New South Wales. At Sandakan or Elopura (North-East Borneo) the present capital of the North Borneo Settlement, there are high cliffs of red and yellow sandstone, which look older than anything I saw on the north or north-eastern coast. Over 600 feet are exposed in one cliff, with no signs of any carboniferous strata.

While at Sandakan I met the Governor's private secretary (Mr. D. D. Daly), who had just returned from a journey of exploration on the Kinebetungen River. He brought down many samples of good coal, besides tin and gold. Amongst the collection were some limestones very like the rocks I had seen in the Malay peninsula. These also form detached mountains. There are fine caves, I am informed, over 600 feet high, and in them are found some of the best kinds of edible birds' nests. Amid the fragments of limestone I recognised a Fenestella and a Stenopora. If this rock is of the same formation as the limestone outliers of the whole of Malaysia, then its age may be for the present considered as Palæozoic, and probably between Devonian and Carboniferous.

After visiting some islands of the Sooloo Archipelago (all volcanic) I went to the Philippines. At Luzon, Mindoro, and some of the larger members of the group, the rocks are principally volcanic. But it would be an error to regard them as exclusively so. There are some areas of stratified rocks with coral and other marine fossils, which are of probably Miocene and Pliocene age. In Mindanao there is gold. I obtained a few fossils from the Miocene beds of the latter island. They were all Foraminifera in a loose friable limestone, including *Orbulina universa*, D'Orb., *Globigerina biloba*, *triloba*, and *bulloides*, D'Orb., *Cristellaria italica*, D'Orb., *Pulvinulina Haueri*, D'Orb., *Rotlaia simplex*, D'Orb., and some others belonging to about twenty different genera. The same species are found in Luzon, and the beds are considered Eocene by Kusrer (see *Boletin de la Carta Geol. del. España*, vol. vii).

One of the most interesting portions of the Philippines is the Calamianes group, a small cluster of islands a short distance south and west of Mindoro. Here we find repeated the main geological features of the Malayan peninsula, with the addition of recent volcanic emanations. To the east of Busuanga (the largest of the group) is the Island of Coron, which presents to the sea a magnificent rampart of limestone cliffs and pinnacles from 600 to 1500 feet high. The aspect is grandly picturesque, but the character of the formation is unmistakably similar to the isolated limestone mountains in the Malayan Peninsula. The rocks are bluish-gray, with apparently a perpendicular stratification, with patches of brilliant colours, including red, yellow, pink, dark and light green, &c. The cliffs descend precipitously into about forty fathoms of water, but at the tidal line they are undermined by the action of the waves in a very cleanly-cut line. Occasionally one may see the natives (Visayas) lowering each other over these dizzy heights to gather the edible birds' nests which here also abound, and form the only valuable export from the islands. The outline of the island is magnificently rugged and irregular, weathered into needles and pinnacles of the most fantastic shape, in the recesses of which there is much pale green grass and patches of darker jungle. Caves are of course numerous. It was the birds'-nesting harvest at the time of my visit in March last.

The Island of Malagou, to the westward is similar to Culion, but it possesses the additional feature of a second line excavated by the waves about ten feet above the actual level. This seems to be the result of upheaval. Besides Malagou there are many small limestone islets, or mere pinnacles of grotesque shape. The seas are thus rendered peculiarly dangerous. The only port worthy of the name is Port Culion, with a town which is a mere cluster of Malay huts of bamboo and palm-leaves. The rocks are Palæozoic schists and quartzites. Thus we have a repetition of the formations as they occur in the Malayan Peninsula.

At Palawan and Mindanao the same formations are stated to occur. Of Mindanao there can be no doubt, but of Palawan little is known, and I have only seen the coast at a distance.

There is a continuance of the same geological features in South China, at least from those portions of the coast which I have seen between Macao and Swatow. At Hong Kong we have granite, ancient trap-rocks, felsites, and detached outliers of limestone exactly like the Palæozoic deposits all through the Eastern Archipelago. From the Canton River the same rocks have been seen by me together with well-marked Palæozoic fossils of carboniferous type (*Spirifer* especially).

I have never succeeded in getting away from the alluvial deposits of the great rivers of Cochin China. Just now the time could not be more unfavourable for any kind of exploration, but I believe the French are not neglecting the geology of the country.

Coal is extensively distributed in all the northern portions of the countries I have been describing. It is found in South China abundantly, Formosa, Tonquin, the Philippines, Japan, and Borneo, and I believe I have seen indications of a carbonaceous deposit in the Malay Peninsula.

Of the coals in South China little more is known than that they are abundant and of good quality. From the fossils I have seen they are probably of Palæozoic age. The Formosa coals are so bad that they have ceased to be worked or at least offered in the Hong Kong market. I know nothing of their age nor of the quality and age of the coals of Tonquin. The coals of the Philippines belong most probably to the Borneo older series. They are found on the south of Luzon and south of Zebu since 1827. More recently they have been found in the province of Albay (south-east of Manilla) and in Panay.

Samples from the latter mines were tried by the P. and O. Company with good results. The Japan coals are certainly Tertiary and most probably Miocene. Though brittle, they make such good steam coals that they are preferred to every other except Cardiff coal. Borneo is a mass of coal, and, as I believe, of very different ages. Those of Labuan were said to be Tertiary; those of Brunei look much older. But I question the Tertiary age of the Labuan beds.

The general character of the geology of the regions I have mentioned is (1) Granite rocks with older volcanic dykes; (2) Palæozoic schists and slates; (3) Limestones in detached outliers, probably of Carboniferous age; (4) Coal of various ages. There has been little upheaval, and that has revealed marine, Miocene, and Pliocene beds, with some few carbonaceous deposits.

J. E. TENISON-WOODS

Osaka, Japan, September 24, 1885

JOHN HUNTER'S HOUSE

EARL'S COURT HOUSE, once the residence of the illustrious John Hunter, has been made very properly the subject of a letter in the *Times* of Tuesday last, by Dr. Farquharson, M.P. The house, with which I have been familiar for the past twenty-two years, is well worth all the attention of the curious which Dr. Farquharson claims for it. It differs, no doubt, somewhat from what it was in Hunter's time, but not so much, I think, as my friend supposes; for a drawing I have had made of it, when compared with another drawing taken not long after Hunter's death, and now in the possession of the Royal College of Surgeons, shows no very important change. The Lions' Den, of which I have also had a faithful copy taken, is still in good preservation, and Mrs. Hunter's boudoir retains all its original character, as she, the accomplished authoress of the well-known song,—

"My mother bids me bind my hair,"—

had it herself decorated. The copper in which the Irish giant was boiled down is in good order, and stands in an outhouse in the same place in which it stood when the giant, in piecemeal, found his way into it. In 1850 the late distinguished scholar, Dr. Robert Willis, of Barnes, took me to Kensington to see a man who remembered John Hunter. He was the son of Hunter's gardener, and was ten years of age at the time of Hunter's death in 1793. This man related some curious anecdotes of the great anatomist. One of these had reference to his presence of mind. One day as Hunter was entering his garden by the field at the back, still a field, one of the lions had got loose from its den. From the house the people called out to Hunter to get out of the way into a place of safety. Instead of this he took his handkerchief from his pocket, and marching boldly up to the lion, flipped it back into the den, and securely shut it in.

That Hunter conducted dissections in this place is clear from the remains that have been dug up in the garden. I examined a number of bones that were thus unearthed by the late occupier during some improvements which were going on about fifteen years ago. The bones showed some sections and re-sections of so curious and skilful a kind, that I asked and obtained permission to retain a few of them.

Upon the death of John Hunter, Earl's Court, held for a time by Mrs. Hunter, and by more than one future occupier, was turned into an asylum for ladies under restraint for lunacy, was held for many years as that by the Misses Bonney, and got the general name of "Miss Bonney's House" or Asylum. In 1864 it passed, still as an asylum, into the possession of my late friend Dr. Gardner Hill, who played so great a part as the practical pioneer of the system of the treatment of the insane without restraint. Dr. Hill continued to reside in the house till his death, by apoplexy, a few years ago, and his family have held it since his death up to the close of the past year, when they left it on the expiration of their lease. The fate of the house will almost certainly be its absorption, with its grounds, into a square or a series of streets, so that nothing will remain of it beyond the views which I and others who are given to antiquarian research may have taken of it, and at my instance Mr. Gardner has added several views to his magnificent collection of London. The memory of the place is thus secured for the future at least. But I agree with my learned brother Farquharson that the copper ought to go to the Hunterian Museum, to join the giant who is already so conspicuous and famous there.

BENJAMIN WARD RICHARDSON

NOTES

AN American Pasteur Institute has been incorporated in New York, its declared objects being the study and treatment of rabies and diseases susceptible of inoculation.

THE Rev. Thomas John Main, formerly Fellow of St. John's College, Cambridge, and a chaplain in the Royal Navy, died on the 28th ult. Mr. Main took his Bachelor's degree at St. John's College in 1838, as Senior Wrangler and first Smith's Prizeman, and proceeded M.A. in due course. He was for a period of thirty-four years Professor of Mathematics at the Royal Naval College at Portsmouth. Mr. Main was the author of various works on the marine steam-engine.

THE death is announced from St. Petersburg of Prof. Zakharow, of the University there, an eminent Orientalist. Nearly thirty years ago he went to China as a Russian missionary, and after General Ignatieff's Treaty of Pekin in 1860, he was employed, on account of his knowledge of Chinese and Manchu, in the work of delimiting the frontier created by that treaty. He then prepared a large map of this region, of which only one copy has been made, which is at present in the Russian Topographical Department. He also compiled a Manchu-Russian dictionary, published in 1875, and a Chinese-Manchu-Russian dictionary was almost completed at the time of his death. On his return to Europe he was appointed Professor of Manchu in the University of St. Petersburg, and in addition to his dictionaries compiled also a grammar of that language, which is now dying out in China, as the Manchus are a mere handful in the midst of the Chinese Empire, and are gradually losing their special tongue. Manchu is, however, still used at Chinese Court ceremonials, and in officially addressing the Emperor of China in person. M. Zakharow's great works have therefore a special value.

THE Association for the Improvement of Geometrical Teaching will hold its annual general meeting on Friday, January 15, at 11.30 a.m., at University College, Gower Street. At the afternoon meeting (2 p.m.) the President (R. B. Hayward, F.R.S.) will give an address on the Correlation of the Different Branches of Elementary Mathematics. A discussion will follow the reading of the address. Persons interested in the objects of the Association or in the subject of the address are cordially invited to attend.

THE Prince of Wales having expressed his desire that specimens of Australian fish might be exhibited in the Aquarium which will be opened in connection with the forthcoming Indian and Colonial Exhibition, the Trustees of the Melbourne Exhibition Building have given the matter their consideration, with a view of determining if specimens of therarer varieties could be sent from the Melbourne Aquarium. It has, however, been found that very great cost would be incurred in sending anything like an adequate supply of fish, and the project has therefore